THE

JOURNAL OF ECONOMIC BIOLOGY.

NOTES ON THE WARBLE-FLY OF THE REINDEER, *OEDEMAGENA TARANDI* (LINN.).[1]

By

GEORGE H. CARPENTER, B.Sc., Lond., M.R.I.A.,

Professor of Zoology in the Royal College of Science, Dublin, and President of the Association of Economic Biologists.

With Plate III, and 12 Figures.

In April of the present year, a gelding Reindeer was received at the Dublin Zoological Gardens. The animal was in very poor condition, and the bad state of its health was due, at least in part, to the large number of warble-maggots with which it was infested. During the months of May and June as many as 104 of these parasites were squeezed from the animal's back. As naturalists not resident in high northern latitudes have but scant opportunity of studying this interesting insect, a few observations on its various stages may be worthy of record.

Thirty-seven of the larvae came into my hands, seventeen of which had been obtained on May 7th and twenty on May 28th. Having repeatedly tried, without success, to rear flies from squeezed-out maggets of the common Ox Warble (*Hypoderma*), I was agreeably surprised to notice that one of the earlier batch of larvae formed an apparently normal puparium in the course of a few days. From this emerged on June 22nd a female fly in perfect condition, the pupal period having thus lasted about six weeks, the period which I have found usual for the development of imagos of *Hypoderma* in this country.

The Larva.

The maggot of *Oedemagena* was described half a century ago by Brauer ('58, p. 406, '63, pp. 133-4), from specimens in the final

[1] Read before the Association of Economic Biologists, Manchester Meeting, July 7th, 1910.

larval instar varying in length from 22 to 30 mm., none of them, according to Brauer's opinion, being quite "ripe." The examples which I have had the opportunity of examining this year are mostly from 23 to 28 mm. in length the dimension varies according to the distension of the cuticle but three specimens are distinctly smaller, having attained a length of 15-18 mm. only.

As regards the main external features of the larva, there is little to be added to the description of Brauer, who remarks that the maggot of *Oe. tarandi* differs from those of allied species in the similarity of the spiny armature on the dorsal and ventral surfaces. In the larvae of *Hypoderma bovis* and *H. lineata*, for example, the rows of spines towards the front edges of the body segments are very poorly developed on the dorsal aspect. But on the dorsal surface of the *Oe. tarandi* larva there are strong, blackish spines, arranged in two, three or four irregular rows towards the front border of each body-segment from the second to the eighth inclusive, while on the ventral surface similar rows of spines are present on the ninth and tenth segments, in addition to those anterior. The arrangement of these spines is clearly shown in the appended photographs (Pl. iii. figs. A, B, and C), showing the larva from the dorsal, lateral, and ventral aspects respectively. If these series of spines be studied in detail, it is found that they are irregular and unsymmetrical. The drawings of the dorsal (Fig. 4) and ventral (Fig. 1) aspects of the

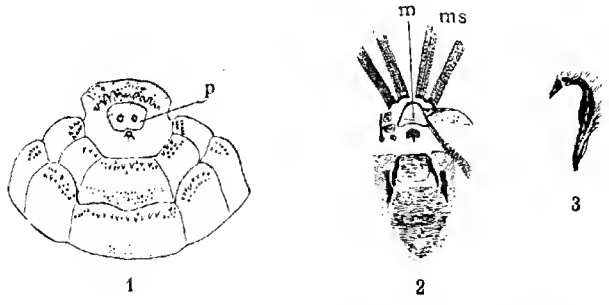


Fig. 1.—Head and two anterior body-segments of larva, ventral view. Magnified 5 times. *p.* pre-oral sclerite, behind which is seen the small mouth.

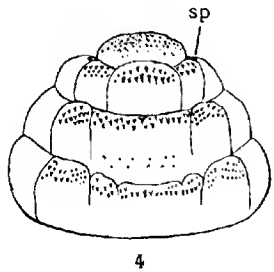
Fig. 2.—Mouth, mouth-hooks, and supporting sclerites, as seen after removal of the dorsal pharyngeal wall. Magnified 50 times. *m.* mouth. *ms.* muscles attached to the mouth-hooks. On the left are shown the small intermediate sclerites; on the right the chitinized area around the mouth.

Fig. 3.—Median chitinized region of ventral pharyngeal wall with supporting sclerites. Lateral view. Magnified 50 times.

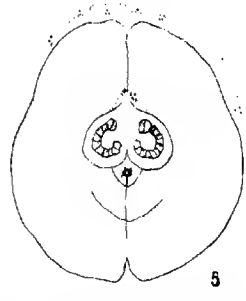
front end of the larva, represent fairly the differences that may be observed between the right and the left side.

In his figure of the head region of this larva, Brauer ('63, p. viii, fig. 4) shows a large number of minute spines in front of the mouth-plate. In the specimens which I have examined, I find on either side a row of from four to six strong spines, very sharp and prominent, and in some cases bifid (Fig. 1).

The mouth-hooks of this larva, like those of *Hypoderma*, are very small. The ventral pharyngeal wall is strongly chitinized, with transverse ridges, forming a firm dark median region (Fig. 2), which passes on either side into a distinct longitudinal sclerite. To these are attached other paired sclerites associated with an anterior, transverse chitinized area. In dorsal view these sclerites appear narrow (Fig. 2), seen laterally they are deep and arched anteriorly and ventral-wards (Fig. 3). In front of the chitinized area is a median dentate sclerite, which lies just behind the mouth (Fig. 2, *m.*), dorsal to which may be seen, when in the retracted state, the small mouth-hooks, each shaped like a double bow and worked by two strap-shaped muscles (Fig. 2, *ms*). Between the mouth hook of either side and the basal ventral sclerite, lie a slender longitudinal and three small plate-like sclerites.



4



5

Fig. 4.—Anterior dorsal region of larva which forms "lid" of puparium. Magnified 5 times. *sp.* anterior spiracles. The posterior line of suture is in front of the hind series of spines on the third body-segment.

Fig. 5.—Hinder end of larva showing spiracular area, horse-shoe shaped spiracular plates and small anus. Magnified 8 times.

In the *Hypoderma* larva, the suture surrounding the anterior dorsal region, which will form the "lid" of the puparium, is very distinct. In the maggot of *Oedemagena* it is, perhaps, even plainer (Pl. iii, figs. A and B). The outline of this region, as bounded by

the suture, can be seen in the drawing (fig. 4), which shows the arrangement of its spiny armature. The anterior spiracles are situated laterally (Fig. 4, *sp.*) close to this suture and to the dorsal head sclerite.

The hinder spiracular area is heart-shaped, with the small anal opening situated just ventral to it. Each spiracular plate is of the horse-shoe form usual in the group, and under fair magnification can be seen to consist of eight or more quadrangular or V-shaped plates (Fig. 5).

The Puparium.

The puparium of *Oedemagena* closely resembles that of *Hypoderma* in its general form and its firm, black cuticle. The spiny armature and posterior spiracles of the larva are easily recognisable in the hardened puparium, from which the dorsal part of the head region and of the first, second, and most of the third trunk-segments split off so as to allow the imago to escape (Pl. iii, figs. D, E and F).

The Imago.

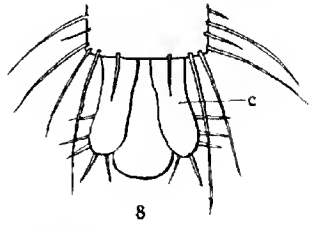
Many former writers from Linné onwards have described the fly, of whose structure there is little new to record, especially as I succeeded in rearing only a single female specimen. This individual, however, had the terminal abdominal segments which form the ovipositor fully extended (Pl. iii, fig. G). The fifth abdominal segment is sub-conical in form, and, like the two preceding segments, is densely clothed with reddish hairs. The short cylindrical sixth segment has a cuticle which, though black and rough, is entirely membraneous, and bears a few black hairs at its extremity (fig. 6, vi). The elongate seventh segment is strengthened by a sclerite which, beginning in front as a narrow, dorsal strip, broadens towards the hinder end, where it reaches to the ventral aspect, its posterior edge being bordered with a few reddish hairs (Figs. 6 and 7, vii). This is succeeded by a stretch of intersegmental membrane, as long as either the seventh or the eighth segment. The latter (Figs. 6 and 7, viii) has a narrow median membranous dorsal region, but the sides and the ventral aspect are protected by a continuous, firm, shining black sclerite, bearing scattered red hairs at its extremity. Behind this segment are visible the dorsal median process—the tergite of the ninth segment according to Hewitt ('07, p. 432) which is smooth and rounded, and the somewhat shorter and narrower lateral processes or cercopods (Fig. 8, c). Each of these bears a group of five stout spines directed outward and backwards. When the apparatus is retracted the eighth segment is

6

7

Fig. 6.—Terminal abdominal segments (ovipositor) of female fly, fully extended. Lateral view. Magnified 8 times. vi, vii, viii, mark the dorsal aspects of the sixth, seventh and eighth abdominal segments.

Fig. 7.—The same, partly extended. Dorsal view. The sixth segment is withdrawn within the fifth, and the eighth is largely hidden by the inturned intersegmental membrane.



8

Fig. 8.—Tip of ovipositor. Ventral view. Magnified 50 times. *c*. cercopod. Between the two cercopods the dorsal sclerite is visible.

drawn back into the tubular intersegmental membrane, which is itself inverted and telescoped into the seventh segment. This latter is in its turn drawn back into the sixth, which is inverted within the fifth segment. When these segments are fully extended they form a telescopic ovipositor as long as the rest of the abdomen. The organ is relatively longer than in *Hypoderma*, and in the details of its structure it differs from the ovipositor of *Musca* recently described by Hewitt ('07), in which the tubular sixth, seventh and eighth abdominal segments are strengthened only by narrow chitinous rods.

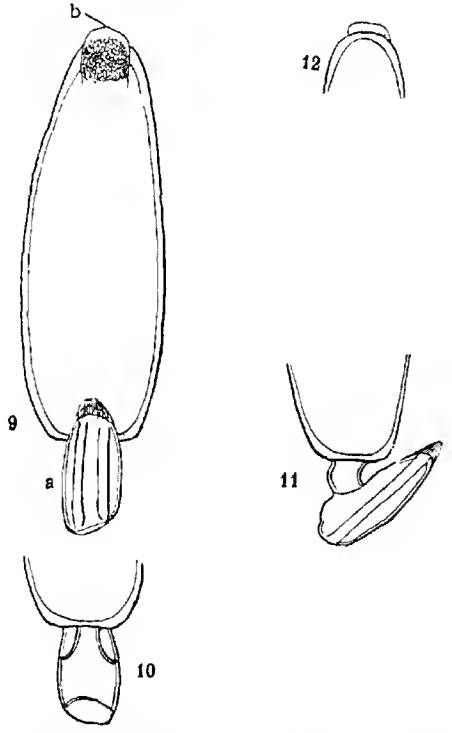


Fig. 9.—Egg seen from attachment aspect. *a*, grooved flange for attachment. *b*, reticulated "lid" area.

Fig. 10.—Base of Egg showing flange from opposite face.

Fig. 11.—Base of Egg, side view, showing flange and stalk.

Fig. 12.—Top of Egg, opposite aspect from fig. 9.

Figs. 9–12 are magnified 80 times.

The Egg.

From the body of the single female at my disposal I extracted a number of eggs for comparison with the eggs of *Hypoderma*. In most respects the resemblance is very close. In *Oedemagena*, as in *Hypoderma*, the egg is elongate oval, rounded at both extremities; in the case of *Oedemagena*, however, the outline towards the attachment-process tends to be slightly sub-quadrate (Figs. 9 and 11). The attachment-process, with its flange and longitudinal grove (Figs. 9, 10 and 11) adapted for fitting over a hair of the host-animal, is closely like that of the Ox Warble flies' eggs. One small, but possibly important distinctive feature is the presence at the free end of the egg of *Oedemagena* of a thin flap, marked with fine reticulations (figs. 9*b* and 12), along whose edge the egg-case splits open very readily. Its position and appearance recalls those of the "lid" of the egg of the Horse Bot fly (*Gastrophilus*) and suggest the probability of the young maggots of *Oedemagena* being licked and swallowed by the Reindeer immediately on hatching, subsequently making their way through the gullet-wall and reaching the skin of the back from beneath, as is now believed to be the case with regard to the maggots of *Hypoderma*.

In the egg of *Hypoderma*, however, no such "lid" can be distinguished, the whole distal region of the egg-case having a firm and even surface. This fact lends support to the suggestion recently made by Jost ('07)—that the host of *Hypoderma* swallows, not the young maggot, but the egg, which is presumably hatched within the digestive tract. Such a difference between the early life-history of *Hypoderma* and that of *Oedemagena* would be interesting. Further observation may perhaps show if belief in its existence be warranted.

REFERENCES.

'58. **Brauer, F.**—Die Oestriden des Hochwildes, u.s.w. Verhandl. K. K. zool. bot. Gesellschaft. in Wien, 1858, viii.

'63. ————Monographie der Oestriden. Wien, 1863.

'07. **Hewitt, C. G.**—The Structure, Development and Bionomics of the House-fly. Pt. 1, Quart. Journ. Micr. Sci. 1907, vol. li.

'07. **Jost, H.**—Beiträge zur Kenntnis des Entwicklungsganges der Larve von *Hypoderma bovis*. Zeitsch. f. wiss. Zool., 1907, vol. lxxxvi.

EXPLANATION OF PLATE III.

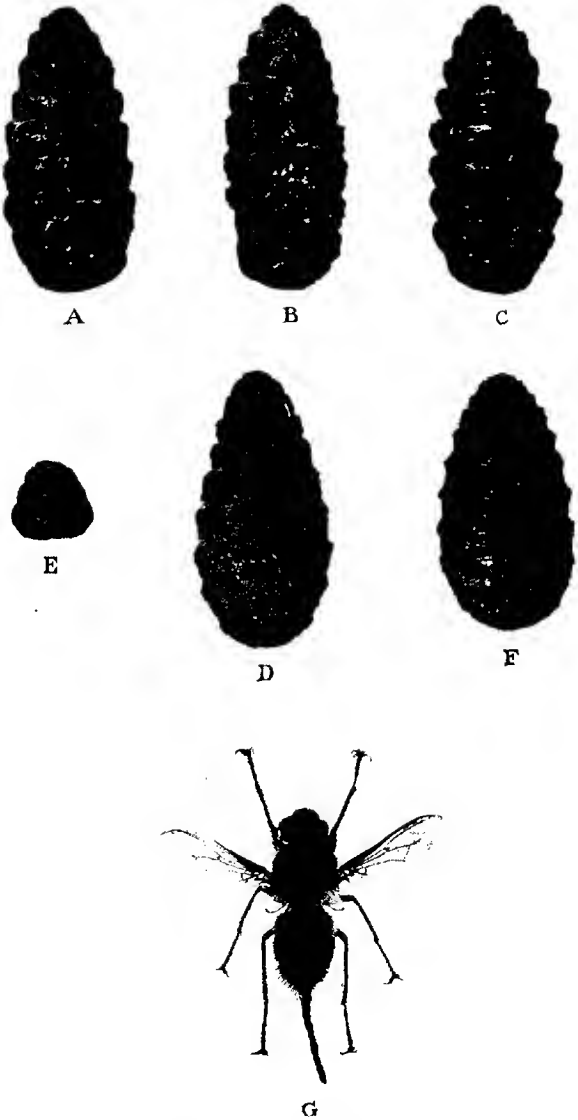
Illustrating Professor George H. Carpenter's paper "On the Warble Fly of the Reindeer."

Fig. A.—*Oedemagena tarandi* (Linn.). Fully grown larva, dorsal view.
Fig. B.— ,, ,, lateral view.
Fig. C.— ,, ,, ventral view.
Fig. D.— ,, Puparium, dorsal view.
Fig. E.— ,, "Lid" of puparium.
Fig. F.— ,, Puparium, ventral view.

Figures A—F., twice natural size.

Fig. G.— ,, Female imago with extended ovipositor, $1\frac{3}{4}$ times natural size.

From photographs by T. Price.



OEDEMAGENA TARANDI *(Linn.)*.

THE EFFECT OF CERTAIN REAGENTS ON HIDES.

By

W. F. COOPER, B.A. (Cantab.), and W. H. NUTTALL, F.I.C.

The question of finding some reliable deterrent against insect infestation of our domestic animals, is of the greatest economic importance. In this country, as in others, a large number of hides are rendered unfit for use by the tanner, owing to their penetration by "Warble." The Tick is responsible for a much greater loss, not only in hides, but in the animals themselves, this being specially so in warmer countries. Further, we have the Blow-fly in Australia, which is spreading rapidly, and is seriously impeding sheep raising in that country.

Up to the present, no satisfactory reagent is known, which will prevent the infestation of animals by these pests. Dipping or Spraying with arsenical preparations is one of the most successful means of controlling Ticks; but it fails, inasmuch as it has very little deterrent effect. Against Warbles, no remedy is known, and recourse is had to squeezing out the immature pupae.[1] Similarly also, we have no means of dealing with the Blow fly.

Any substance which might be adapted to this end, should have the following properties. Firstly, it should be cheap enough to be used on a large scale; secondly, it must remain on the hair, wool, or skin for a considerable time, and resist inclement weather; thirdly, it must have a persistent taste or odour, objectionable to the pest.

There are a large number of chemicals having these properties; such as Picric Acid, Pyridine, Commercial Methylene Blue, Mercury Salts, Lead Salts. Many, however, appeared to be open to two serious objections; either the greater number of substances which would combine with the skin, are dyes and cause discolouration; or else they are such as have some chemical action on the constituents of the skin. In either of these cases, the tanning properties of the hides might be seriously interfered with; so much so, as to render them as unfit for the tanner as though they were punctured by the Warble.

[1] See Journ. Board of Agric., vol. 17, p. 659.

In order to test the effect of such chemicals upon the tanning properties of the skin, the authors carried out some experiments with a few of them; though, as experimental tanning is expensive, the size and number of the skins had to be limited.

The substances selected were Picric Acid, Pyridine Picrate, and Mercury Bichloride. The first is a persistent dye, and has a very bitter taste. The second was tried as being a dye, and also because it gradually decomposes and evolves odours which were expected to be disagreeable to the pests. The third was tried on account of its power of combining with gelatine and of precipitating Tannin, which property, it was considered, might interfere with tanning.

A whole skin of an adult ox was taken and cut into four quarters. Three of these were treated with the three substances; the fourth was kept as control, untreated.

The skin was stretched on the ground, hair side up, then a 1 per cent. solution of the substance in water was poured upon it and worked in with a brush. A large amount was applied so that thorough penetration might take place. After leaving to soak, and then hanging up to drain, they were allowed to dry in the sun, packed up, and sent off to be tanned. The fourth piece was merely salted, as is generally done abroad in the ordinary course of drying skins.

The skins were sent to Dr. Gordon Parker to be tanned, and he reported "That the treatment had not interfered with the tanning in any way." The four pieces were absolutely similar in colour, texture, etc.; also, two local authorities were unable to pick out the piece which had not been treated: so that it is evident that the application of the materials had not interfered with the tanning; and therefore, as far as any objection to tanning is concerned, there is no reason why a large number of other dyes and chemicals should not be tried as a means of controlling and preventing other infestations by many pests.

For instance, *Hypoderma bovis* lays its eggs on the lower portions of the oxen's legs; from here, they are transferred to the stomach by the animal in licking itself. Some of the dyes, such as Picric Acid, or Commercial Methylene Blue (which contains Zinc Chloride) have a very bitter taste, and, if applied to the animal's legs, they might prevent the licking of those parts. It would be interesting, at least, to try driving some cattle through a trough containing a solution of Picric Acid, or some other similar compound and comparing them with animals not so treated.

In the case of the Blow-fly in Australia, Copper Sulphate is employed, though it cannot be said to be satisfactory.

One of us made a preliminary experiment to try the effect of

spraying Picric Acid, Isopurpuric Acid or Grenat Soluble (a compound of Picric Acid and Prussic Acid), and Methylene Blue, on to clean beasts and exposing them to Tick infection in South Africa; the results were not altogether promising, and, unfortunately, the work could not be repeated or continued. We consider that there is a large and untried field in the application of dyes and certain metallic salts to these purposes. From these experiments, at all events, it would appear that there need be no apprehension of any interference in the process of tanning, or of loss in colour of the tanned pelt.

REVIEWS.

Adams, Isabel H.—Wild Flowers of the British Isles. Revised by J. E. Ragnall. Vol. ii, pp. xi + 199, 62 cold. plts. London: William Heinemann, 1910. Price 30s. net.

The second volume of Mrs. Adams's work on British wild flowers fully maintains the high standard set in the previous volume. The two volumes complete the subject with the exception of aquatic plants and trees, and we sincerely hope that the authoress will at least add a third volume treating of the former, and so complete a work most ably executed, beautifully illustrated, and excellently produced. Amongst the very numerous volumes treating of our British wild flowers, we know of none that supply so much accurate information in so concise a manner, and there are certainly none more profusely or better illustrated. The able assistants, whose names are recorded, are mostly well-known botanists, and their contributions have undoubtedly added to the completeness of this most desirable volume.

W. E. C.

Bancroft, Keith.—A Handbook of the Fungus Diseases of West Indian Plants. Pp. 70, 6 plts. London: Geo. Pulman & Sons, Ltd., 1910.

The author of this little handbook gives, in a small compass, a useful account of the fungus diseases of West Indian Plants.

After a short introduction, in which Mr. Bancroft indicates the chief problems in connection with West Indian plant pathology, the different diseases are described in systematic order. A technical diagnosis of the fungus and references to the more important literature, together with a description of field symptoms, and the treatment to be followed, is given in the case of all the more important fungi.

The book should prove of material service to all concerned in the raising of crops in the West Indies.

W. E. C.

Doncaster, L.—Heredity in the Light of Recent Research. Pp. x + 140, 12 figs. Cambridge University Press, 1910. Price 1s.

There is undoubtedly a growing interest in, and keen appreciation of the recent advances made in the wide and complex subject of Heredity. With the recent and excellent works of Bateson, Lock, Thomson, and Punnett, we should have thought there was hardly room for another, even though it were a small one, unless it were a distinct advance upon these;

we must therefore confess some disappointment at Mr. Doncaster's little book. It is distinctly feeble, and does not add anything to what we already know. It may serve a useful purpose possibly, to those who do not wish to possess more than a conversational knowledge of the subject.

W. E. C.

Duggar, B. M. Fungous Diseases of Plants. Pp. xii + 508, 240 figs. Boston: Ginn and Company, 1910.

Professor Duggar's book will be equally welcome to British students of mycology as to those in America, for it treats of numerous diseases due to fungi common to both countries.

The plan of the work is excellent. After a careful and eminently practical account of culture methods and technique, and physiological relations, we have the general account of the different diseases in systematic order. Each disease is given under its popular name, followed by the scientific name of the fungus, and references to a few of the leading papers on the subject, indeed, wherever one looks, full acknowledgment is given to the work of other investigators. In the discussion of each disease three important considerations have been kept in view, viz.: (1) a description of the pathological effects and other relations of host and parasite; (2) a clear, yet concise, account of the life-history of the fungus; and (3) a brief account of the approved or suggested methods of the prevention or control. The illustrations, which are numerous, are all very good, and greatly add to the value of the text. In conclusion we have a host index of the fungous diseases described or cited.

We have nothing but the highest praise for this admirable handbook, which is deserving of a wide recognition both in the laboratory and field.

W. E. C.

Eltringham, H.—African Mimetic Butterflies. Pp. 136, 10 cold. plts. and a map. Oxford: The Clarendon Press, 1910. Price £2 12s. 6d.

The author of this interesting work states that he has endeavoured to compile into one volume the information contained in many publications together with drawings of specimens from several collections, and it is hoped that others may find in the result, materials of some interest and a basis for further research.

There is a valuable introduction, in which the author gives a general account of animal coloration and mimicry, and discusses the views of other workers; this is followed by descriptions of mimetic associations in African Rhopalacera; a chapter is devoted to objections which have been raised to the theories of mimicry, and the evidence on which such theories are based; another to the consideration of the evidence that some butterflies are more palatable than others; and a final one to the evidence that butterflies are preyed upon by birds. The work concludes with a brief review of general conclusions, bibliography, and a good index.

The ten coloured plates are on the whole good, but it is a thousand pities that they were not printed on white paper. Plate 3 is perhaps the worst, spoilt purely by the background.

W. E. C.

Lafar, Franz. Technical Mycology: the Utilization of Micro-organisms in the Arts and Manufacturs. Translated by Charles T. C. Salter. Vol. ii, pt. ii, pp. ix + 192-748, 50 figs. London: Charles Griffin and Co., Ltd., 1910. Price 18s. net.

The previous parts of Mr. Salter's translation of Dr. Lafar's well known work have been before the public for some time, and we welcome the second part of volume ii, thus concluding the work.

The present part is especially interesting, treating as it does of Yeast Nutrition and Yeast Culture at considerable length.

Dr. Klöcker describes the life-history and variability of the Saccharomycetes, and the classification of the family and Schizosaccharomycetaceae. The morphology and classification of certain technically important higher Ascomycetes and allied forms, and the chemical activity of the Aspergillaceae are treated of by Dr. Carl Wehmer. The general morphology, physiology, and classification of technically important budding fungi of the group "Fungi Imperfecti," are dealt with by Dr. H. Will, Dr. R. Meissner, Dr. H. Müller-Thurgau, and Dr. H. Wichmann; whilst the enzymes and enzyme actions of yeast are ably described by Dr. R. Rapp, Dr. Bau, Dr. Hahn, and the author.

There is an excellent Bibliography and index.

To brewers, distillers, analysts, pharmacists, and technical and agricultural chemists, there is a wealth of information of the greatest practical value, and it is such that will welcome and appreciate a standard modern text-book on this all-important subject.

McAlpine, D.—The Smuts of Australia: their Structure, Life-history, Treatment, and Classification. Pp. vii + 285, 57 plts. and 6 figs. Melbourne: Department of Agriculture, Victoria, 1910.

This is a companion volume to the author's work on the *Rusts of Australia*, the two volumes forming a notable contribution to mycological literature.

The mode of treatment is similar to that previously followed: the first part treats of the general subject of smuts, the second and third with the life-histories and treatment of those attacking cereals and grasses, these are followed by an account of the field experiments carried out during 1909, the fifth and final part dealing with the classification and technical descriptions. A useful bibliography, host index, and general index complete a most satisfactory volume.

The thoroughness with which the author has dealt with his subject, in

so clear and comprehensive a manner, and the accuracy and fulness of detail, with a wealth of illustration, make this volume a most valuable contribution to the subject, which cannot fail to meet with the same flattering reception extended to its companion.

W. E. C.

Pycraft, W. P.—A History of Birds. With an Introduction by Sir Ray Lankester. Pp. xxxi + 458, 37 plts. and 50 figs. London: Methuen and Co., 1910. Price 10s. 6d. net.

During the past few years we have had numerous works purporting to treat of bird-life, in most of which we have been surprised at the little information they contained and the total absence of first-hand knowledge. The work before us is of a very different nature. As Sir Ray Lankester states in his introduction, it does "not start with a scheme of classification and then take up the groups one by one," but generally discusses the numerous phenomena which make the study of bird-life so fascinating. Thus we have first a general introduction pointing out the general characters of structure, followed by two chapters on the phylogeny, and others on geographical distribution, the relations of birds to the seasons, migration, the relations of birds to plants and animals, peculiar interrelations, and the relation of the sexes. The subject of nests, eggs, care of offspring and nestlings are dealt with at considerable length. Variation acquired characters, natural and artificial selection, adaptions and convergence of form are all very fully discussed.

Information on such points as the origin of nests, food-storing, parasitic birds, causes of migration, interbreeding, weapons, isolation and its significance, influence of food on colour, and a host of other facts, make Mr. Pycraft's work a most valuable and a complete epitomé of bird-life. The illustrations are excellent. In short, it is by far the best work on birds we have, and one we have stood in need of for some time past.

W. E. C.

CURRENT LITERATURE.

I.—General Subject.

Ballou, H. A.—Nomenclature of Scale Insects. W. I. Bull., 1910, vol. xi, pp. 35-38.

Bernstein, J.—Summary of Literature relating to the Bionomics of the Parasitic Fungus of Flies: *Empusa muscae* (Cohn), with special reference to the Economic Aspect. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 41-44.

Collins, C. W.—Some results from feeding eggs of *Porthetria dispar* to Birds. Journ. Econ. Entom., 1910, vol. iii, pp. 343-346.

Reiff, W.—Some Experiments on the Resistance of Gypsy Moth Eggs to the Digestive Fluids of Birds. Psyche, 1910, pp. 161-164.

Urich, F. W.—Annual Report of the Entomologist. Bd. of Agric., Trinidad, 1910, pp. 1-6.

II.—Anatomy, Physiology, and Development.

Backhoff, P.—Die Entwicklung des Copulationsapparates von *Agrion*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 647-706, Taf. xxi, 29 figs.

Bauer, A.—Die Muskulatur von *Dytiscus marginalis*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 594-646, 19 figs.

Hasper, M.—Zur Entwicklung der Geschlechtsorgane von *Chironomus*. Zool. Anz., 1910, Bd. xxxv, pp. 737-743, 5 figs.

Nüsslin, O.—Zur Anatomie und Biologie der Borkenkäfergattung *Cryphalus*. Naturw. Zeits. Forst. u. Land., 1910, pp. 289-298, 5 figs.

Snodgrass, R. E.—The Anatomy of the Honey Bee. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 18, 1910, pp. 1-162, 57 figs.

An excellent and most useful piece of work.

Solowiow, P.—Ban der Stigmen bei den Larven *Cimbex*. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 271-275, 9 figs.

Vogel, R. Uber die Innervierung und die Sinnesorgane des Schmetterlingsflügels. Zool. Anz., 1910, Bd. 36, pp. 193-204, 5 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Burr, Malcolm.—The Dermaptera (Earwigs) of the United States National Museum. Proc. U.S. Nat. Mus., 1910, vol. 38, pp. 443-467, figs. 1-8.

Carpenter, Geo. H.—On some Subantarctic Collembola. Subantarctic Islands of New Zealand. Wellington, 1909, pp. 377-382, plt. xviii.

Records *Achorutes viaticus*, Tullb., and *Triacanthella alba*, n. sp.

Coquillett, C. W.—The Type-species of the North American Genera of Diptera. Proc. U.S. Nat. Mus., 1910, vol. xxxvii, pp. 499-647.

Davidson, W. M.—Further notes on the *Aphididae* collected in the vicinity of Stanford University. Journ. Econ. Entom., 1910, vol. iii, pp. 372-381, 2 figs.

Essig, E. O.—Some Variations in the Wings and Antennae of *Trifidaphis radicicola*, Essig. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 283-285, 13 figs.

Girault, A. A., and G. E. Sanders.—The Chalcidoid Parasites of *Musca domestica*, Linn., and its Allies. Psyche, 1910, pp. 108-117, 145-160, 5 figs.

Glaue, H.—Beitrage zu einer Monographie der Nematodenspecies *Ascaris felis* und *Ascaris canis*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 551-593, 26 fign.

Gravely, F. H.—Pedipalpi of Ceylon. Spolia Zeylanica, 1910, vol. vii, pp. 43-47, 3 figs.

Grossbeck, J. A.—Studies of the North American Geometrid Moths of the Genus *Pero*. Proc. U.S. Nat. Mus., 1910, vol. 38, pp. 359-377, plts. 13-16.

Hall, H. V. M.—A Phytoptid Gall on *Artemisia californica*. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 280-281, 2 figs.

Harding, H. A.—The Constancy of Certain Physiological Characters in the Classification of Bacteria. N.Y. Agric. Exp. Stat., Geneva, 1910, Tech. Bull. No. 13, pp. 3-41, 3 charts.

Imms, A. D.—The Habits and Distribution of *Scutigera* in India. Nature, 1910 (Oct. 6th), p. 429.

Johannsen, O. A. The *Mycetophilidae* of North America. Agric. Exp. Stat., Orono, Maine, Bull. No. 180, Pt. II, 1910, pp. 125-192, 4 plts.

Kieffer, J. J.—Description de nouveaux Hyménoptères. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 105-117.

Kieffer, J. J. Cecidomyies parasites de *Diaspis* sur le Mûrier. Ibid., 1910, vol. iv, pp. 128-133, 3 figs.

Kieffer, J. J. Description de quelques Diptères exotiques. Ibid., pp. 327-328, 1 fig.

Kieffer, J. J. Nouveaux Cynipides exotiques. Ibid., pp. 329-342.

Kieffer, J. J. Description de nouveaux Scelionides d'Angleterre. Ibid., 343-345.

No figures are given.

Kleine, R. Biologische Beobachtungen an *Dendrosoter protuberans*, Nees. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 289-292, 1 fig.

Leonardi, G. Die neuen Species di *Mesurodicus*, Douglas. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 316-322, 4 figs.

Martelli, G. Altre notizie dietologiche della mosca delle olive. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 73-104, 9 figs.

Martelli, G. Notizie sulla *Drosophila ampelophila*, Liv. Ibid., 1910, vol. iv, pp. 163-174, 6 figs.

Martelli, G. Sulla micofagia dell Coccinellide *Thea vigintiduo-punctata*, L. Ibid, 1910, vol. iv, pp. 292-294, 1 fig.

Martelli, G. —Per la conoscenza delle convittime del *Dibrachys boucheanus* (Ratz.). Ibid., pp. 323-324.

Masi, L.—Contribuzione alla conoscenza dei Calcididi italiani. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 3-37, 28 figs.

Patch, Edith M.—Four rare Aphid Genera from Maine. Agric. Exp. Stat., Orono, Maine, Bull. No. 182, 1910, pp. 241-248, 6 plts.

Paoli, G. Sulla *Sarcophaga lineata*, Fallen, parassita dello *Stauronotus maroccanus* (Thunb.) in Sardegna. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 347-352.

Pierce, W. D. —Some New Species of Weevils of Economic Importance. Journ. Econ. Entom., 1910, vol. iii, pp. 356-366.

Rohwer, S. A.—Some New Hymenopterous Insects from the Philippine Islands. Proc. U.S. Nat. Mus., 1910, vol. xxxvii, pp. 657-660.

Brief description of 1 new genus and 5 new species, none of which are figured.

Sicard, A.—Description d'une espece nouvelle de Coccinellide de l'Afrique du Sud. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 118-119.

Silvestri, F. Metamorfosi del *Cybocephalus rufitrons*, Reitter. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 221-227, 6 figs.

Silvestri, F.—Contribuzioni alla conoscenza dei Chilopodi. III, IV. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 38-95, 10 figs.

Smith, J. D. The *Noctuidae* of California. II. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 275-279.

Trotter, A.—Le cognizioni cecidologiche e terratologiche di Ulisse Aldrovandi e della sua Scuola. Marcellia, 1910, vol. ix, pp. 111-120.

Viereck, H. L. Descriptions of New Species of Ichneumon-Flies. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 379-384, 3 figs.

Wheeler, W. M. The Effects of parasitic and other Finds of Castration in Insects. Journ. Exp. Zool., 1910, vol. 8, pp. 377-438, 8 figs.

Wolcott, A. B. Notes on some *Cleridae* of Middle and North America, with descriptions of new species. Field Mus. N.H., Zool. Ser., 1910, vol. vii, no. 10, pp. 339-401, plts. v, vi.

IV. Agriculture and Horticulture.

Ainslie, Geo. G.—The Cowpea Curculio (*Chalcodermus aeneus*, Boh.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. viii, 1910, pp. 129-142, figs. 67-69.

Bancroft, C. K. A New West Indian Cacao Pod Disease. W.I. Bull., 1910, vol. xi, pp. 34, 35, 1 plt.

Carpenter, Geo. H. Injurious Insects and other Animals observed in Ireland during the year 1909. Ec. Proc. Roy. Dub. Soc., 1910, vol. ii, pp. 8-30, plt. ii, 10 figs.

Coleman, L. C. Diseases of the Areca Palm. I. Koleroga. Dept. Agric. Mysore State, Bull. No. 2, Mycolog. Ser., 1910, pp. vii + 92, plts. i-xviii, 6 figs.

The disease known as Koleroga or Rot-disease of the Areca Palm is one of the most serious plant diseases in Southern India, and entails an annual loss of at least 3 to 4 lakhs of rupees. Dr. Coleman's report of his recent investigations will therefore be welcomed as giving a very thorough account of the disease, the conditions influencing the growth and spread of the fungus, combative measures, and the experiments that have been carried out. He further describes the disease and the species of Phytophthora causing it, and other points of interest, the whole of which are excellently illustrated.

Essig, E. O.—Spraying for the Citrus Mealy Bug. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 246-259.

Essig, E. O.—The Natural Enemies of the Citrus Mealy Bug. II. Ibid., pp. 260-274, 3 figs.

Felt, E. P.—Recent observations upon European Insects in America. Journ. Econ. Entom., 1910, vol. iii, pp. 340-343.

Felt, E. P.—Gall Midges of *Aster, Carya, Quercus* and *Salix*. Journ. Econ. Entom., 1910, vol. iii, pp. 347-356.

Felt, E. P.—25th Report of the State Entomologist on Injurious and other Insects of the State of New York, 1909. N.Y. State Mus., Bull. 141, 1910, pp. 3-178, 22 plts., 1 fig.

As usual, Dr. Felt's report is full of interesting and valuable matter. Chief amongst the injurious species are accounts of the typhoid or house fly, brown tail moth, codling moth, hickory leaf stem borer, and rhododendron lace bug.

A useful list of the insect types in the New York State Museum is given, and Mr. D. B. Young contributes an additional list of Adirondack insects. The usual notes for the year, publications and additions to collections complete this 25th report.

Foster, S. W.—On the Nut-feeding Habits of the Codling Moth. U.S. Dept. Agric., Bur. of Entom., Bull. No. 80, pt. v, 1910, pp. 67-70, plts. vii, viii.

Gillette, C. P. Plant Louse Notes, Family *Aphididae*. Journ. Econ. Entom., 1910, vol. iii, pp. 367-371, 24 figs.

Hardenberg, C. B.—The Codling Moth in the Transvaal. Transv. Agric. Journ., 1910, vol. viii, pp. 635-640, 2 plts.

Holmes, E. S.—"Scab" and Eelworm in Potatoes. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 570-582.

Laidlaw, W.—The Potato Eel-Worm. Journ. Dept. Agric., Viet., 1910, vol. viii, pp. 508-511, 1 fig.

Lounsbury, Chas. P.—Fourth Annual Report of the Committee of the South African Central Locust Bureau. Pp. 59, 2 plts., 15 maps. Cape Town: Cape Times Ltd., 1910.

McAlpine, D.—The Genuine Locust Fungus (*Empusa grylli*, Fres.). Journ. Dept. Agric. Vict., 1910, vol. viii, pp. 434-436, 20 figs.

McRae, W.—Report on the Outbreak of Blister Blight on Tea in the Darjeeling District in 1908-1909. Agric. Research Inst. Pusa, Bull. No. 18, 1910, pp. 1-19, plts. i-vi.

Martelli, G.—Sulla presenza del maschis dell' *Icerya Purkasi*, Mask. in Italia. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 290-291, 1 fig.

Martelli, G.—Alcune note intorno ai costumi ed ai danni della mosca delle arance (*Ceratitis capitata*, Wied.). Ibid., 1910, vol. iv, pp. 120-127, 1 fig.

Martelli, G.—Notizie sui costumi del *Ceratoceras corniger* (Walk.). Ibid., pp. 325-326.

Patch, Edith M., and O. A. Johannsen.—Apple Tree Insects of Maine. Agric. Exp. Stat., Orono, Maine, 1910, pp. 1-68, 4 plts.

Phillips, E. F.—Bees. U.S. Dept. Agric., Farmers' Bull. 397, 1910, pp. 1-44, 21 figs.

Pierce, W. M.—Fumigation Studies. III. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 241-245, 6 figs.

Quaintance, A. L.—The San Jose Scale and its Control. U.S. Dept. Agric., Bur. of Entom., Circ. No. 124, 1910, pp. 1-18, 10 figs.

Quelch, J. J.—Report on the Giant Moth-Borer. With Notes on the Small Moth-Borer and the Beetle-Borer. Pp. 32, 1 plt., Georgetown, Demerara: "The Argosy" Company, Ltd., 1910.

Deals very fully with *Castnia licus*, with notes on *Diatraea saccharalis*, and *Sphenophorus sericeus*.

Rorer, J. B.—The Froghopper Fungus. Bd. of Agric., Trinidad, 1910, pp. 9, 10.

Sackett, W. G. Stem Blight, a New Bacterial Disease of Alfalfa. Colorado Agric. Exp. Stat., Bull. 159, 1910, pp. 3-15, 1 plt.

The cause of the blight is *Pseudomonas medicaginis*, n.sp., which, presumably, lives in the soil, and enters the plants with soil through stems that are cracked and split by late frosts.

Silvestri, F.—Introduzione in italia d'un Imenottero indiano per combattere la mosca delle arance. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 228-245, 8 figs.

Silvestri, F.—Contribuzioni alla conoscenza degli insetti dannosi e dei lors simbionti. Ibid., pp. 246-289, 25 figs.

South, F. W.—The Control of Scale Insects in the British West Indies by means of Fungoid Parasites. W.I. Bull., 1910, vol. xi, pp. 1-30, 10 figs.

Urich, F. W.—Interim Report on Froghoppers. Bd. of Agric., Trinidad, 1910, pp. 3-8.

Wildermuth, V. L.—The Clover-root Curculio (*Sitones hispidulus*, Fab.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. iii, 1910, pp. 29-38, 5 figs.

V.—Forestry.

Butler, E. J.—The Bud-Rot of Palms in India. Mem. Dept. Agric. India., Bot. Ser., 1910, vol. iii, no. 5, pp. 221-280, plts. i-v.

Hewitt, C. G. Insects destructive to Canadian Forests. First Ann. Rpt. Comms. Conservation, 1910, pp. 1-12.

Patch, Edith M. Gall Aphids from the Elm. Agric. Exp. Stat., Orono, Maine, Bull. No. 181, 1910, pp. 193-240, 13 plts.

Stebbing, E. P. A Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-borer." Forest Zool. Ser. No. 2, Pamph. No. 15, 1910, pp. 1-18, plts. i, ii.

VI. Fisheries.

VII.—Medicine and Human Parasites.

Copeman, S. M.—Note as to work on hand, but not yet published; and as to proposed further work in reference to Flies as Carriers of Infection. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 45-48, 1 fig.

Graham-Smith, G. S. Observations on the ways in which Artificially-infected Flies (*Musca domestica*) carry and distribute Pathogenic and other Bacteria. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 1-41, plts. i-vii, 25 Tables.

Hewitt, C. G.—House-flies and the Public Health. Ottawa Nat., 1910, vol. xxiv, pp. 31-35.

Ross, R.—A Summary of Facts regarding Malaria suitable for Public Instruction. Pp. 15. London: John Murray, 1910. Price 2d.

Malarial fever is perhaps at the present time the most important of human diseases. In India alone it has been officially estimated to kill every year on the average 1,130,000 persons. The subject has been long and patiently studied, and at last it may be said that final success has been assured. Major Ronald Ross, of the Liverpool School of Tropical Medicine, whose recent work, "The Prevention of Malaria," is probably the most exhaustive and authoritative treatise on the subject, has issued a pamphlet which should prove of the greatest possible value in making known to the general public the best practical, every-day means for preventing the spread of the disease. With a view to widespread distribution, it is published at the nominal price of 2d. (postage 1d. for 3 copies), by Mr. John Murray, Albemarle Street, London, W.

Todd, J. L.—A Review of the Recent Advances in our Knowledge of Tropical Diseases. John Hopkins Hosp. Bull., 1910, vol. xxi, pp. 1-18.

VIII.—Animal Diseases, etc.

Carpenter, Geo. H., and T. H. Corson. The Warble Flies. Third Report on Experiments as to Life-History and Treatment. Journ. Dept. Agric. and Tech. Instr. Ireland, 1910, vol. x, pp. 1-10, 1 plt.

THE JOURNAL OF ECONOMIC BIOLOGY.

Volume V, pt. 3, October 20th, 1910.

Page 134, line 12, and 8 from bottom, for "suggestine" *read* "suggestive."

Page 136, line 5 from bottom, for "in larval characters" *read* "on larval characters."

Page 137, line 3 from top, for "not the unbanded" *read* "nor the unbanded."

PROCEEDINGS

OF THE

ASSOCIATION OF ECONOMIC BIOLOGISTS.

ANNUAL MEETING, July 6-8, 1910.

WEDNESDAY, JULY 6TH, 1910.

The Ninth Annual Meeting was held in the Beyer Buildings of the University of Manchester.

Professor S. J. Hickson, F.R.S., occupied the chair, and on behalf of the University of Manchester offered a welcome to the Association.

The minutes of the previous meeting were read, confirmed, and signed.

The following gentlemen were elected members of the Association: S. J. Hickson, F.R.S., T. G. B. Osborn, B.Sc., Theodore Rettie, D.Sc., and C. B. Saunders, B.Sc.

Mr. Collinge read the following Annual Report.

FIFTH ANNUAL REPORT.

In presenting their Fifth Annual Report (covering the period from July, 1909, to July, 1910), your Council are pleased to report a continued steady growth in the numerical strength of the Association.

The total number of members of all classes on June 30th, 1910, was 118, namely:—

Honorary	...	...	...	...	8
Ordinary	...	...	...	..	98
Associate	...	...	...	...	12
					118

There are also four candidates awaiting election.

A successful meeting was held at the University of Oxford on July 13th, 14th, and 15th, 1909.

The total receipts up to June 30th, 1910, amounted to £169 8s. 5d., whilst the total expenditure for the same period amounted to £55 8s. 6d., leaving a balance in the hands of the Hon. Treasurer of £113 19s. 11d.

There is also a balance of £47 2s. 3d. due for outstanding subscriptions.

In accordance with Law 12, the Council nominated the following as Officers of the Association for the year 1910 to 1911. No further nominations having been received these were put to the meeting and declared elected.

President:

PROFESSOR GEO. H. CARPENTER, B.Sc., M.R.I.A., F.E.S.

Vice-Presidents:

PROFESSOR J. B. FARMER, M.A., D.Sc. (Oxon), F.R.S.
SIR PATRICK MANSON, K.C.M.G., LL.D., M.D., F.R.S.
PROFESSOR G. H. F. NUTTALL, M.A., M.D., Sc.D., F.R.S.
PROFESSOR E. B. POULTON, M.A., D.Sc., F.R.S.
PROFESSOR RONALD ROSS, C.B., F.R.C.S., F.R.S.

Council:

PROFESSOR PERCY GROOM, M.A., D.Sc., F.L.S.
R. STEWART MACDOUGALL, M.A., D.Sc., F.R.S.E.
FRANCIS H. A. MARSHALL, M.A., D.Sc., F.R.S.E.
ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.
A. E. SHIPLEY, M.A., Hon. D.Sc., F.R.S.
HERBERT STONE, F.L.S.
FRASER STORY, F.R.S.E.
CECIL WARBURTON, M.A.

Hon. Treasurer:

R. T. LEIPER, M.B., Ch.B., F.Z.S.

Hon. Secretaries:

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.
W. G. FREEMAN, B.Sc., A.R.C.S., F.L.S.

Professor Geo. H. Carpenter took the chair on his election as President.

The following alterations in the Laws were then read.

In accordance with Law 18, the Council propose the following alterations in the Laws:—

Law 10. "Three shall form a quorum at all meetings" (instead of five, as at present).

Law 12. In place of "three Vice-Presidents," *read* "three or more Vice-Presidents."

Law 18. Par. (1) The omission of the words "and be read and lie on the table at a General Meeting to enable Notice of Amendments to be given."

No amendments having been received the proposition was put to the meeting and declared carried.

The President delivered his Presidential Address entitled "Biology—Pure and Applied."

BIOLOGY—PURE AND APPLIED.

By

Professor GEORGE H. CARPENTER, B.Sc., M.R.I.A.

In assuming the Presidency of this Association, I wish in the first place to express my hearty thanks to my colleagues for the unexpected and undeserved honour which they have done me in calling me to the office. The diffidence that I felt when I received the invitation of the Council returns now that I find myself face to face with this ninth Meeting of the Association, and step into the place vacated by our friend Dr. A. E. Shipley, who for the past four years has filled with such ability, distinction, and enthusiasm, the presidential chair. My colleagues will testify that I use no words of flattery when I say that Dr. Shipley has so discharged his duties as to set before his successor a high standard of achievement. The excellence of the outgoing is the difficulty of the incoming president. Yet all the more on the account of my difficulties do I rely on the sympathetic help and support of my colleagues, whom I can promise that at least I will do my best.

Some friends at home to whom I have confided the news of the honour to be conferred on me here at Manchester enquired with some interest as to the nature of those special biologists who describe themselves as "economic." Did the name, they asked, imply that these votaries of the science of life abjure first-class travel and expensive hotels? I replied that biologists generally follow a pursuit which, however fascinating, does not bring to their pockets such extensive material gains as justify lavish expenditure, and that any

biologist does well to practise economy, especially if he support a family. Then I proceeded to a linguistic discussion on the difference between the words "economical" and "economic," which, I trust, left my friends in possession of a clear idea of the aims of our Association.

This discussion led me to think over the relation between the economic and the more general aspects of biology, and I have become so bold as to offer to my colleagues a few remarks on this wide and possibly well-worn subject rather than to review any special line of enquiry in our science. The very existence of our Association, and the success that it has achieved, bear witness to the advantage of organization among those biologists whose work deals largely with economic problems. At the same time the names of our supporters, the standard of the papers read at our meetings, or published in our Journal, remind us that the advancement of science is our aim, as it is the aim of those biologists who are not specially interested in economic questions. I rejoice in the work of our Association because it brings home to us the inspiring thought that there is no hard-drawn frontier line between what is called "applied" or "economic," and what is called "pure" science. Are we not all students of the one great fascinating and mysterious science of life?

Our Association does well to uphold this principle, because there still lingers much of that sectarian spirit which has often marred the work and the mutual relations of different sets of scientific men. This spirit, on the one hand, is embodied in the well-known though possibly apocryphal toast: "Here's to the latest scientific discovery, and may it never do a pennyworth of good to anybody," or in the saying of one of the great men of my city that a University is essentially a place for the cultivation of useless knowledge. Under such sayings lurks the assumption that useless knowledge must be "purer" than knowledge which can benefit mankind, and must confer on its followers a certain distinction and dignity which is altogether wanting in those whose work leads to results of definite utility. But the workers in economic science show, on their side, the same intolerant spirit when they refuse to undertake themselves and discourage others from undertaking, research that will not lead obviously to some material gain. It will be our part to cultivate that truly catholic spirit which recognizes the whole field of science "pure" and "applied" as one. It is convenient to have a society of economic biologists. It is convenient also to have societies of mycologists or entomologists, but the naturalist with a comprehensive general outlook will make the best special student of moulds or midges. And that economic biologist is the best equipped who

realizes most clearly that his researches, even if "useful," tend to advance knowledge, and that any path of enquiry apparently the most "useless" may lead to results of high economic value. He refuses to call his pursuits "common and unclean," because they have a practical bearing on the work of the physician or the farmer. But he recognizes that gain for himself or others gives poor inspiration for research; pressing steadily on in pursuit of truth, he trusts that in due time the material benefit will be added, and his faith is not disappointed.

It may serve as a corrective to the sectarian spirit, and as an encouraging introduction to our meeting, if we recall a few instances, among many that might be cited, of the mutual indebtedness between "pure" and "economic" biology. How often has the academic worker opened up some line of research that has afterwards proved most fruitful to the leaders of industry. How often, too, have investigations, primarily undertaken with an economic object, led to results of surpassing interest and importance to the students of pure science.

In the history of human thought we cannot doubt that biology appealed to man first of all as an applied science. Primitive, barbarous, and often civilized men approach zoology from the standpoint of the hunter or the fisher, study comparative anatomy as an aid to surgery, and become gardeners or herbalists long before they become botanists. Then the living creatures appeal to their human exploiters, as worthy of study in themselves, and from such studies men learn facts that enable them to make an increasingly profitable use of the animals and plants flourishing around them.

In no branch of biology has our knowledge been more remarkably increased in recent years than among those Protozoa that are parasitic in the blood-corpuscles and plasma of vertebrates—the Sporozoan Haemosporidia and the Haemoflagellata—and no better example could perhaps be afforded, than by the study of this group, of the marvellous results—fruitful equally in the advance of human science, the relief of human suffering, and the saving of human life—that have been brought about by researches carried on, some with, and others without special reference to considerations of definite utility. Let us review in briefest outline the story of these researches. Mayer and Gruby had described before 1850 the Trypanosoma of the frog; Lankester in 1871 discovered the first-known Haemosporidian, Drepanidium, in the blood of the same animal. What discoveries could be imagined promising less practical benefit to mankind than the determination of such minute and obscure Protozoa in the cold-blooded martyr of the zoological laboratory? Yet the

next stage in the history of sporozoan research was the recognition (in 1882) by Laveran of the malarial parasite in the human blood, though he erroneously believed it to be a plant, and it was left to Metchnikoff to elucidate its true sporozoan affinities. Meanwhile, Danilewsky had, by his researches on the blood of birds, demonstrated that warm-blooded vertebrates might be hosts of Trypanosomes. Then the interest of research into these parasitic Protozoa became mainly medical. The hypothesis that the malarial parasites were conveyed from one vertebrate host to another by means of a blood-sucking arthropod such as a gnat or tick, was before the end of the last century established beyond dispute by the brilliant labours of Ross and his followers. The wonderful life-history of the typical Haemosporidia, the asexual fission in the blood of the vertebrate alternating with sexual reproduction and subsequent sporulation, in the body of the gnat, was made known to an admiring world, and in the elucidation of this life-history the comparative study of human and bird-haunting parasites played an important and indispensable part. Reverting to the flagellate parasites, we remember how Bruce in 1897 showed that the dreaded African horse and cattle disease is due to a Trypanosome, of which the Tsetse fly (Glossina) acts as a host alternately with the affected mammal, and how subsequently a number of eager workers have described haemoflagellates in many species of all the great vertebrate classes. Of supreme interest among these, is the Trypanosome whose passage from the human blood-stream into the cerebrospinal cavities causes the terrible sleeping-sickness of Tropical Africa.

These facts are so familiar that it may seem needless to call attention to them again before this Association. But I wish to dwell upon the thought that these later researches, carried out largely by physicians and surgeons with the direct object of combating disease, have led to results of surpassing interest to the philosophical naturalist. The existence of various complex adaptations for parasitism in two hosts, with a correspondingly complex life-cycle among minute unicellular organisms, has opened up far-reaching problems in classification and phylogeny. In these life-cycles we find typical sexual reproduction, previously unknown among the Protozoa, but now throwing a suggestive light on the probable origin of the germ-cells among the higher animals. And according to the observations of Schaudinn on the blood-parasites of owls, biologists are confronted with the possibility of a close relationship of the Flagellata with the Sporozoa on the one hand, and with Spirochaet-like organisms on the other. All these fascinating problems,

with the activities of that increasing and ardent band of "protozoologists" who strive to solve them, have been made possible by the work of a group of investigators whose primary object was to alleviate the diseases of man and his domestic animals, but who brought the strictest scientific methods to their task, and who were not afraid of pursuing any path of research which promised to lead them to new facts.

The development of Protozoology, then, has been immense during the last fifteen years. And along with it has advanced another branch of zoology to which I may now direct your attention with the feeling that I am passing to ground to myself more appropriate and more familiar. Some of the glamour that surrounds Trypanosoma and Halteridium has passed to the Tsetse and the gnat that harbour them, and the formerly unsuspected pathological importance of the blood-sucking Diptera and Acarina has led to increased interest in entomology among physicians and that large section of intelligent persons who are eager for hygienic progress. Here, again, the economic importance of the organisms has had a stimulating and beneficial effect on their scientific study. Our members are not likely to forget the admirable monograph on the Culicidae of the world which students owe to our first president—F. V. Theobald. It is doubtful if that great work would have been undertaken, but for the pathological importance shown by the work of Ross and his colleagues, to attach to the mosquitoes. In such cases, where certain genera and species of a family act as alternative hosts of deadly micro-organisms while others are harmless, it is obvious that the worker must have at his disposal as complete a systematic knowledge of that family as possible; unless every student be encouraged to widen our knowledge of any species of the family, entirely without reference to its recognized pathological importance, some fact of the greatest pathological importance unseen to us at present, will be lost to us in the future. We rejoice to think that the Entomological Research Committee recently appointed by the Colonial Office, largely, as we know, through the influence of our late president, shows, by its method of work and the nature of its newly published bulletin, that its members recognize no hard and fast barrier between pure and applied biology.

But we twentieth-century workers do well to remember that the same ideals of work inspired our predecessors. Among the pioneers of modern entomology in this country during the early part of the last century, we have notable examples of the combined study of the "pure" and the "applied" science. John Curtis is remembered

not only for his magnificent series of "Illustrations in British Entomology," but also for his classical work on "Farm Insects," in which he set forth many original observations on life-histories. John Obadiah Westwood, that great master in systematic entomology, was keenly interested in the economic aspects of the science, and rejoiced to publish the results of much valuable work in the pages of the *Gardeners' Chronicle*. Interest in the life-histories of insects other than Lepidoptera, has been largely stimulated by the fact that economically harmful insects are commonly injurious in the larval stage; and it often happens that the worker who from the economic standpoint is inclined to curse some destructive grub, remains to admire the details of its structure and to marvel at the beauty of its adaptations.

Perhaps, I may be allowed to give a few instances of the mutual independence of pure and applied entomology that have come within my own experience. For several years past I have made a special study of the lowly wingless springtails or Collembola. To many persons of the straitly utilitarian type of mind such study might well seem useless in the extreme. Yet every year that passes, as our secretary has lately shown us, brings more clearly to light the part often played by springtails as destroyers of plant-roots. The most rigidly economic entomologist simply cannot afford to neglect them, and the enthusiastic admirer of springtails for their own sake may lose much if he despise economic work. Everyone knows that attempts have been made to grow tobacco in Ireland during recent years, and naturally various Hibernian plant-eating insects try their mandibles on the strange new crop. The larvae of Agriotes flourish on the roots of tobacco seedlings in spring, while the caterpillars of *Mamestra brassicae* and *M. oleracea* delight to eat the leaves in autumn. Two years ago there were sent to me from one of the experimental plots seedlings of tobacco, the leaves covered with specimens of a tiny grey springtail—an Isotoma. That insect is a north European species *Isotoma tenella*, Reuter, previously unknown in the British Isles, which might have remained long enough unknown, had not its few and obscure representatives been enticed from their lurking-places by a new and (presumably) pleasant kind of food, provided in large quantity, on which they increased and multiplied so greatly as to alarm the cultivator. In such cases the interest does not lie merely in the record of a species new to the country. To the thoughtful naturalist they are experiments on a large scale from which something can be learnt about the response of organisms to their surroundings. And the introduction of tobacco into Ireland with the showers of tobacco-eating insects which have in consequence

fallen to my lot, convinces me that over a wide area, during successive years, individuals of the same species respond in the same way to a similar stimulus. I believe that the widespread appearance of some insect or other creature "new" as an economic pest is always an illustration of this general principle. What unique opportunities then has the economic worker for studying change of habit under changed condition.

One reason among many why the Collembola and their allies the Thysanura are of such great interest to the zoologist is the presence among them of a pair of jaws—the maxillulae of Hansen intermediate in position between mandibles and maxillae. These maxillulae are known to be present in a reduced condition in insects of several primitive exopterygote orders—Dermaptera, Orthoptera, Corrodentia—but their existence has not been recognized among the higher orders of insects whose members pass through what is called a complete transformation. In the summer of 1908 I received for identification from an Irish farmer a number of root-eating beetle-grubs unknown to me. They were like lamellicorn larvae in build, but with the whole cuticle well chitinised, and they are ultimately proved to belong to the silky oblong-shaped beetle *Dascillus cervinus*. An examination of the jaws which the abundance of material rendered possible—showed the presence of maxillulae, distinct and well-developed in this larva. The immense variety in type exhibited by beetle grubs makes the transformation of the Coleoptera of high import to the student of insectan phyogeny. Here we see a most suggestive morphological fact brought to light as the bye-product of a simple agricultural enquiry.

Such experiences as these bring home to us that the whole field of biology—pure and applied is one, and that the earnest worker receives the due reward of his toil now in new knowledge and now in material benefit for his fellows. The facts of phylogenetic import to which I have just referred remind us that the echoes of the Darwin Centenary have not yet died away, and that the great English naturalist whose memory the whole scientific world honoured last year exhibited in his life-work that union of economic and theoretic interest in biology for which I plead. Need examples be given of this commanding view-point occupied by Darwin? All students of applied biology are taught the surpassing economic importance of earthworms, and the benefit derived from cross-pollination in plants —results at which Darwin arrived through enquiries carried on in the purest spirit of scientific research. And what reader of those books whose evolutionary ideas have dominated modern biology can fail to recognize the debt which Darwin's theoretic work owed to

practical facts due to the labours of the gardener and the breeder?

And, in conclusion, do we not find the most striking illustration of our principle in the work of those naturalists who are to-day carrying on the Darwinian tradition—in Darwin's own University and elsewhere—by their investigations of the phenomena of inheritance and variation inspired by the long forgotten researches of Mendel—themselves researches in which the economic and theoretic aspects of biology are finely joined? It may indeed be doubted if all or even most of the facts of heredity will ever be explained on Mendelian principles, but no student can doubt that by the application of these principles an increasing flood of light is being thrown on many of those facts. And how wonderfully does Mendelian theory applied to agricultural industry help the practical work of the cultivator and the breeder. The farmer has it now within his power to grow corn immune to fungoid disease, and to produce at will domestic animals showing within well-defined approximation, desired features of coat-colour, build, or horn. Who can put limits to the possible development of these principles in the future, and their practical application in the improvement of our domestic animals and plants? It is a suggestive fact that the leader of the English school of Mendelians should have resigned a Cambridge chair to take up the headship of a horticultural station, for we believe that in the midst of economic work, Prof. Bateson will find occasion for research, more illuminating than before, into the problems of heredity. Here surely we have a meeting place for economy and theory. The breeder knows now that "blue" Andalusian fowls can never breed true, and that white cattle will always breed true. The biologist—economic or otherwise—looks, with the eye of a scientific imagination enlightened by thoughtful cytological study, and sees in the germ-cells whence those animals spring the meeting and the sorting of those hidden determinants to which their outward appearance is due. And, while in the light of this vision, many facts of hybridization and reversion become explicable to him, he realizes that "many things are hidden greater than these." Yet he rejoices that in his "common task," which brings help to the workers who toil for the world's daily bread, he is privileged, so far as mortal man yet may be, to penetrate at least within the confines of that temple which enshrines the mysteries of Creative Power.

Professor F. E. Weiss contributed the results of observations on the garden *Tropaeolum*, some plants of which bore flowers of different colour at different seasons of the year. These and other cases of differing flower decoration, *e.g.*, in *Anagallis arvensis*, are

under investigation to ascertain to what degree they are hereditary characters, and to which factors the changes are to be attributed.

On behalf of Dr. Walter Malden, Mr. Collinge read his paper on Diseases of Bees.

Dr. R. Stewart MacDougall, in a most interesting paper, emphasised the importance in dealing with coleopterous enemies of trees —of taking account of the length of life passed in the various stages.

Mr. Walter E. Collinge described the structure of the egg of the Horse Bot Fly, *Gastrophilus equi* (Fabr.), and gave an account of his experiments on their method of hatching.

Thursday, July 7th, 1910.

Professor S. J. Hickson read a paper "On the place of Economic Zoology in a Modern University," in which he pointed out how at present the demand for trained men capable of dealing with agricultural and other pests is in excess of the supply, especially in the colonies. He outlined a scheme for securing to students an efficient grounding in general science combined, by co-operation with experiment stations, with proper practical experience. Stress was laid on the importance of the fourth year's work, and the advisability of securing, if possible, training at a central agricultural college or experiment station, *e.g.*, in India or Ceylon, for those destined for a tropical career.

Professor Carpenter gave an account of the life-history of the Warble-fly of the Reindeer, *Oedemagena tarandi* (Linn).

On behalf of Mr. G. O. Sherrard, the President communicated a paper "On a species of *Rhabditis* injurious to Cress."

Another well discussed and important topic was the problem of wild bird protection, introduced by Walter E. Collinge, who pointed out that under the restrictions imposed by the Wild Birds' Protection Acts some birds had apparently multiplied to an excessive degree. He advocated securing definite knowledge as to which birds were harmful, and taking steps to secure their diminution, *e.g.*, by placing in schools specimens of the eggs of such birds, and offering rewards for their collection. The discussion brought out prominently the difficulty of determining exactly whether certain birds, *e.g.*, the rook, were beneficial or harmful in all districts and at all seasons; and practical suggestions, some of which are already being utilised, for acquiring this necessary knowledge were made.

Mr. W. G. Freeman gave a very full account of "The Economic Importance of the Cambium in Plants."

Dr. R. Stewart MacDougall discussed various problems suggested by the life-history of the Sheep Maggot Fly (*Lucilia sericata*), to which Mr. Collinge added a number of observations.

Mr. Joseph Mangan described the parasites of the large larch sawfly (*Nematus erichsonii*) and the progress of the work being carried out at Thirlmere.

It was announced that on the invitation of Mr. Collinge the Association would hold its next meeting at Birmingham.

Votes of thanks were passed to Profs. Hickson and Weiss for their hospitality, and to Mr. Joseph Mangan for his services as local secretary.

On the invitation of the Council of the Manchester University, the members attended the opening of the Biological Experiment Laboratories at Fallowfield by Sir Thomas Elliot, of the Board of Agriculture and Fisheries, which was followed by a garden party.

INDEX TO VOLUME V.

THE

JOURNAL OF ECONOMIC BIOLOGY

EDITED BY

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists; Honorary Fellow of the Royal Horticultural Society; Joint Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Biologist to the Land Agents' Society, the Midland Reafforesting Association, and the Warwickshire Agricultural Society; late Special Lecturer on Economic Zoology in the University of Birmingham.

With the co-operation of

A. H. REGINALD BULLER, D.Sc., PH.D.,

Professor of Botany in the University of Manitoba, Winnipeg.

GEO. H. CARPENTER, B.Sc., M.R.I.A.,

Professor of Zoology in the Royal College of Science for Ireland, and Consulting Entomologist to the Royal Dublin Society.

PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,

Assistant Professor of Botany, Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., F.R.S., A.L.S., F.E.S.,

Dutton Memorial Professor of Medical Entomology in the Liverpool School of Tropical Medicine, in the University of Liverpool.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,

Master of Christ's College, Cambridge, and Reader in Zoology in the University.

VOLUME VII.

1912.

LONDON:

DULAU AND CO. LTD., 37, SOHO SQUARE, W

1912.

CONTENTS OF VOLUME VII.

LIST OF ILLUSTRATIONS IN VOLUME VII.